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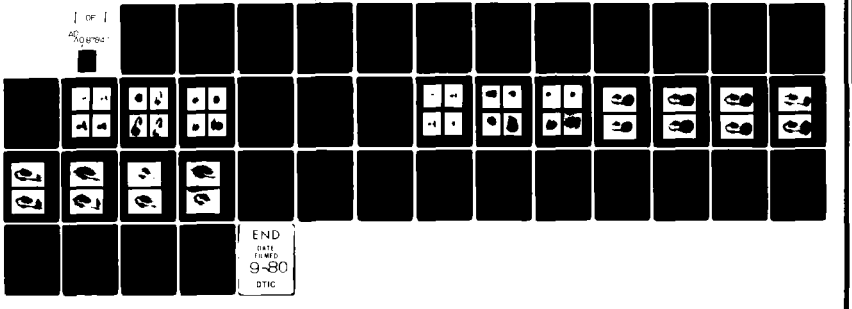

LEVEL II

DNA 5179T

OPTICAL MEASUREMENTS OF LASL OPERATION AVEFRIA BARIUM SHAPED CHARGE RELEASE PHENOMENOLOGY

Technology International Corporation
75 Wiggins Avenue
Bedford, Massachusetts 01730

1 November 1979

Topical Report for Period 1 October 1978—1 October 1979

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Upper Atmosphere
Plasma Structure

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Photographic measurements of the two shaped charge barium releases in the upper atmosphere were made by Technology International Corporation in May 1978 near Tonapah, Nevada. Extensive black and white and color film records were obtained of the detonation geometry and barium ion cloud structure. This report contains a technical pictorial history of each event, measurements of the detonation motion velocities, and a radiometric time history of the ion cloud for the second event.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Avefria barium shaped charge release program consisted of two rocket borne experiments conducted in May 1978 from the Tonapah Test Range, located southeast of Tonapah, Nevada. The test program was conducted by the Los Alamos Scientific Laboratory with the joint support of the Defense Nuclear Agency towards the overall objective of simulating (in part) the condition of an enhanced, disturbed ionosphere following a high altitude nuclear detonation for experimental test purposes. The Avefria program was basically an extension of previous barium injection experiments in the upper atmosphere with emphasis on simulating the combined physical and chemical properties and temporal processes of a late-time nuclear disturbed region of the ionosphere and, the effects of such a disturbed region on electro-magnetic communications signals transmitted through that region.

The Avefria experiments, in contrast to its predecessors, were conducted at a relatively low altitude of (nominal) 195 kilometers with the barium injection direction essentially perpendicular to the local geomagnetic field. The second stage shaped charge payload consisted of 1.45 kilograms of barium metal similar to previous LASL experiment configurations and was detonated on the down leg from a 206 kilometer planned apogee.

The shaped charge type of barium release, in contrast to the thermite-diffusion release, provides a prompt structured ion plasma cloud, in close proximity to the release point. As such, it was possible to plan the Avefria experiments with fixed ground stations to record the characteristics of satellite propagation signals through the structured ion cloud from a known satellite track behind the cloud.

In addition to r-f transmission experiments this program provided an opportunity to establish a suitable geographically coordinated set of optical stations

to gain more detailed information on the phenomonology of striation mechanisms in the shaped charge concept of prompt ion plasma structure formation.

1.2 OBJECTIVES

The primary objectives of the Avefria program were twofold: that of measuring the effect of a structured plasma in the ionosphere on a communications type signal transmitted from a satellite through the cloud; and, the comprehensive optical measurement of the spatial and radiometric history of the barium ion cloud formed during and subsequent to the shaped charge release.

The communications-propagation experiments were specifically directed towards measuring the amplitude and phase scintillations of a steady r-f signal transmitted by a geosynchronous orbiting satellite on a number of phase locked frequencies through the barium cloud to several ground locations.

The optical diagnostics experiments were designed to provide a significantly improved data base on the morphological development of ion cloud (plasma) striations in the upper atmosphere, and the ion density history at selected barium ion emission wavelengths.

The major TIC contribution to the overall optics diagnostics experiment was to provide early time coverage of the plasma-jet release geometry, high resolution measurements of the individual striations, and radiometric measurement of the ion cloud peak brightness at 4554Å wavelength. In addition, color morphology data, time lapse photography, and secondary site coverage was planned for the two events.

1.3 OPERATIONAL PROCEDURE

1.3.1 Site Location

The Avefria experiments were launched from the Tonapah Test Range, Nevada in a generally south east quadrant. In order to view the

release point from both up the field lines as well as perpendicular to the striations, primary optical site locations were established by LASL at Hot Creek Valley, Nevada, and Table Mountain Observatory, California, respectively. Secondary optical sites co-located with the satellite propagation experiment stations were established at Ely, Nevada (two sites) and Antelope Valley, Nevada (one site). TIC co-located with LASL at the Hot Creek Valley primary optical site. In addition to these established sites, an incidental optical site was operated by MRC for TIC at San Marcos Pass, Santa Barbara, California, in conjunction with other MRC experimental observations.

1.3.2 Event Matrix

The Avefria shaped charge releases were borne by Nike Tomahawk rockets operated by Sandia Laboratories. The releases were made at local morning twilight and the ion injection was directed perpendicular to the local geomagnetic field towards a generally northeasterly azimuth. Table 1.1 summarizes the pertinent operational parameters of the Avefria program events, named Uno and Dos.

1.3.3 Instrumentation

The optical instrumentation operated by TIC for DNA in support of the LASL-DNA Avefria program was, as indicated above, geared to providing early release geometry, high resolution striation measurements, and radiometric measurement of the optical brightness of selected barium ion emissions. Although essentially similar overall for each event, the optical instrumentation was changed somewhat between events and is summarized in detail in the TIC instrument plans presented in Appendix A. In general two cine cameras (positions 01, 02) were operated from E-0 to about E+30 seconds, color film being used in one camera for the second event. A time lapse camera (position 03) with color film was operated for each event, and, subsequently, 16mm projection prints were made from the 35mm originals.

TABLE 1.1

OPERATION AVEFRIA EVENT MATRIX

Event	Date	Time	HOB[1]	Yield[2]
UNO	8 May 1978	11:44:00 Z	193.1 km	1.45 kgm
DOS	18 May 1978	11:35:00 Z	190.1 km	1.45 kgm

(1) Post Event Determination

(2) Available barium. Approximately 25% barium metal vaporized with shaped charge.

Color morphology records were obtained continuously throughout the event from the position 04 camera which had a moderately large field of view and a clock for timing each data frame. Operated with this camera in the Uno event only was the ion filter camera (position 05) with a 4554Å narrow band interference filter.

The high resolution Delft System camera (position 06) was operated for limited periods at the time of interest commensurate with the relatively short film load capacity. A back-up camera (position 07) of equivalent focal length but less aperture (compensated in part by more sensitive film) was operated in conjunction with the high resolution Delft System.

A three stage image intensifier camera (position 08) was operated with a 4554Å filter on an intermittent basis for both events, primarily as an evaluation test of this new instrument. The 12^{o} field of view was marginally adequate and a shorter focal length should be used if it were intended to encompass a larger ion cloud in a comparable situation. Finally, another new camera system (position 09) was tested to ascertain the value of a (relatively) high resolution system with a large field of view as well. In general this system was found to have good potential, but would have been of greater value if a suitably fast color emulsion had been used on alternate exposures of this sheet film camera.

1.4 RESULTS SUMMARY

The instrumentation deployed by TIC for the Avefria experiments performed with only one significant malfunction on the Uno event and none on the Dos event. Weather conditions at the Hot Creek Valley site for both of the morning twilight releases were generally good, there being some cirus cloud cover beginning at about E + 6 minutes for the Uno event and no apparent cloud cover on the Dos event. In addition, initial pointing angle update from the LASL experiment coordinators were exceptionally accurate for both events.

As a consequence of the fortunate experimental conditions and successful equipment performance, extensive photographic records were obtained of both the Uno and Dos events. Appendix B summarizes the extent of the data obtained as a function of record number, film type, and framing rate (or exposure time). (Further system parameters can be obtained from Appendix A, noting that the last two digits of the record number correspond to instrument position number)

In general good records were obtained in the following categories:

- Cine coverage of release (both events)
- Time lapse coverage of ion cloud striation development (both events)
- Color morphology coverage of ion and neutral cloud to late times (both events)
- Ion filter coverage at 4554Å (both events)
- High resolution coverage of ion cloud striations (Dos event only)

Worth particular mention are the color cine record of the Dos event detonation and the color high resolution record of the ion cloud striation structure viewed up the field lines.

2.0 TECHNICAL PICTORIAL HISTORY

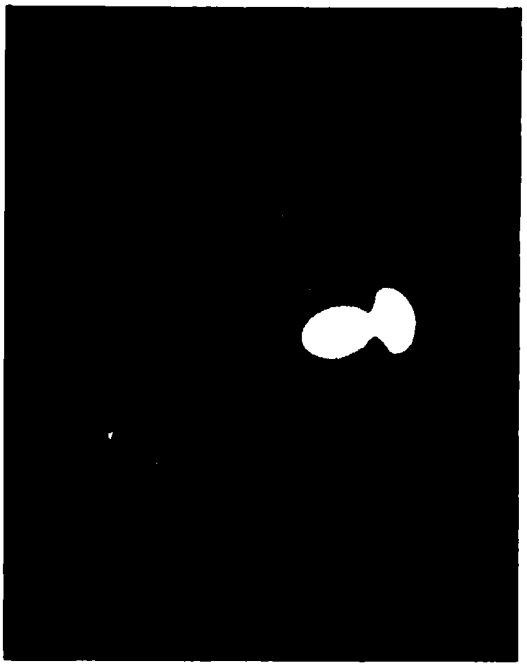
This section contains a selected pictorial history of the morphological development of each of the two Avefria events as recorded with TIC instrumentation from Hot Creek Valley, Nevada and, to a much lesser extent, from San Marcos Pass near Santa Barbara, California. Inasmuch as the Dos event was viewed up the field lines from Hot Creek Valley, a series of high resolution photographs of this event is included in this section.

2.1 AVEFRIA - UNO EVENT

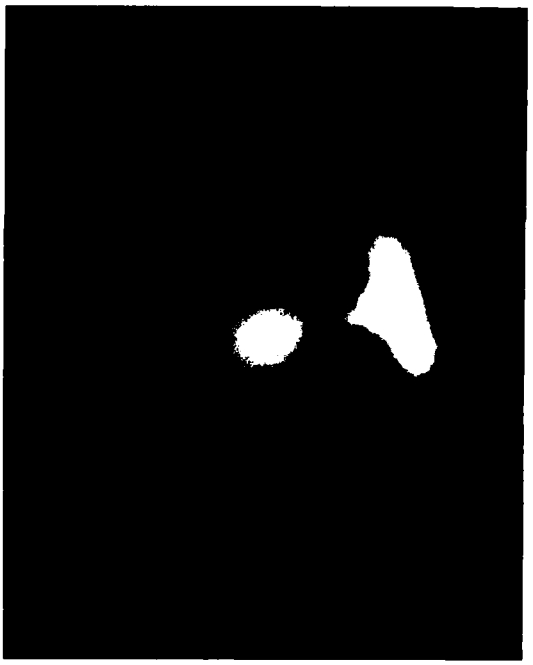
The early shaped charge barium jet motion is depicted in figure 2.1, covering a period of approximately 4 seconds. The burst position corresponds to a point somewhat left of center of the right hand image of figure 2.1a. By about 1 second (figure 2.1b) the jet cloud (moving left) has extended to a length of nearly 12 kilometers and the diameter of the remaining debris cloud is about 8 kilometers. (It might be noted that the apparent color of the clouds at this time are yellow (bariumjet) and bright white (debris)). In figure 2.1b several things are becoming apparent. The partially cone-shaped core of the debris cloud shows definite structure symmetrical about the directed motion axis. This is probably indicative of shock enhancement of the denser inner portion of this cloud. Within the less bright jet cloud region to the left, a centrally located ion cloud structure is beginning to become evident. By E + 4 seconds (figure 2.1d) this ion structure is better defined (although not very obvious in this black and white image) and forming the leading end of the developing ion cloud. Figure 2.2 shows the development of the Uno ion cloud from E + 1 1/2 minutes to E + 5 minutes as viewed from the Hot Creek Valley optics site. The apparent proximity of the ion and neutral clouds is seen in figure 2.2a. As the ion cloud extends in length with time it appears that the early structured end remains closely positioned with the neutral cloud while the initially unstructured end moves further away and itself becomes highly structured. At E + 5 minutes the overall length (projected) of the ion cloud is

approximately 30 kilometers. The width of the group of about 10-12 striations at the end of the cloud in the middle right of figure 2.2d is approximately 6 kilometers. (Note: Width defined perpendicular to striation axis).

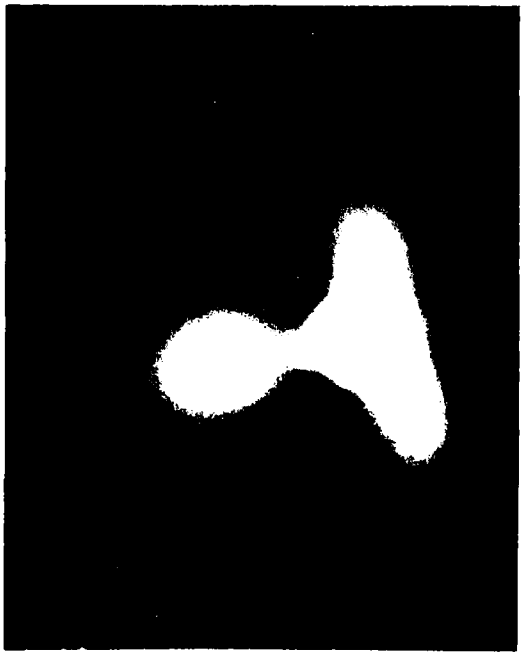
A contrasting view of the Avefria - Uno neutral and ion clouds during the E + 1/2 minute to E + 6 minutes period is shown in figure 2.3. These data frames show the clouds as seen from the Santa Barbara, California area which is south-southwest of the Tonapah Test Range. A cursory inspection of two figures, 2.2 and 2.3, suggests that the first striations shown in figure 2.3a correspond to the structure at the left-center of the ion cloud in figure 2.2a. Correspondingly, the left most group of striations in figure 2.3d are most likely those seen at the center right of figure 2.2d.



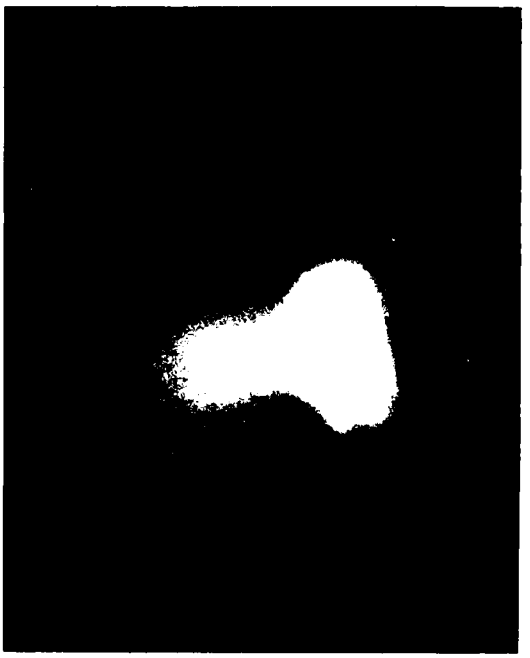
a) frame 0 E + 0.17 sec



b) frame 2 E + 0.8 sec



c) frame 5 E + 1.8 sec



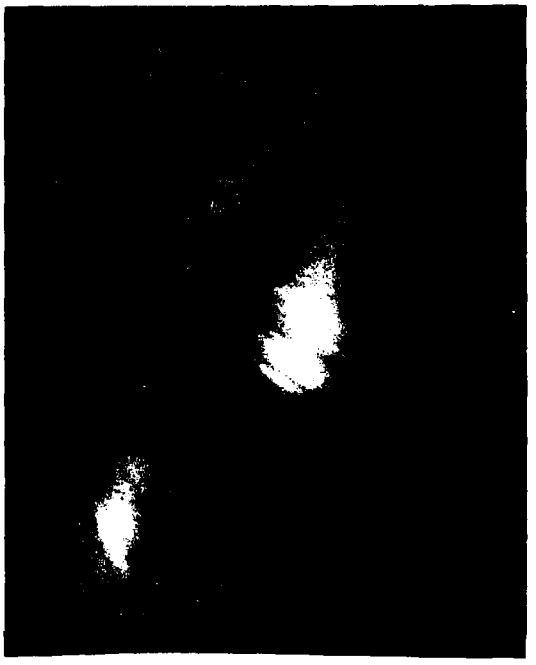
d) frame 12 E + 4.1 sec

Figure 2.1 AVFERIA-UNO Event, Hot Creek Valley, NV, TIC Record 73902

a) frame 2A E + 1 min 32 sec

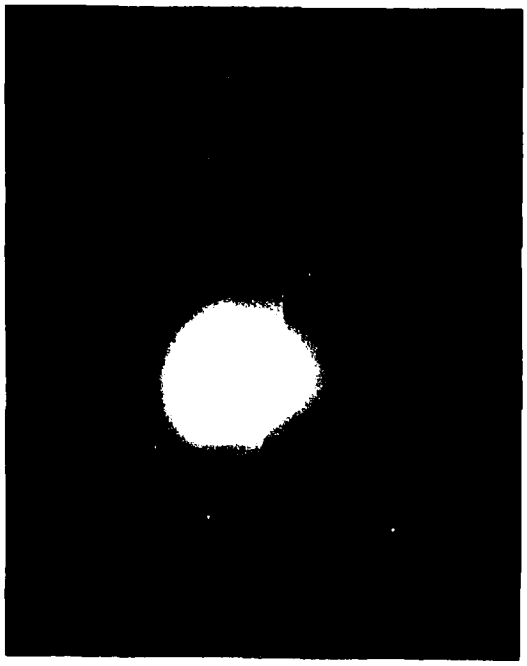
b) frame 3A E + 3 min 17 sec

c) frame 3B E + 4 min 07 sec

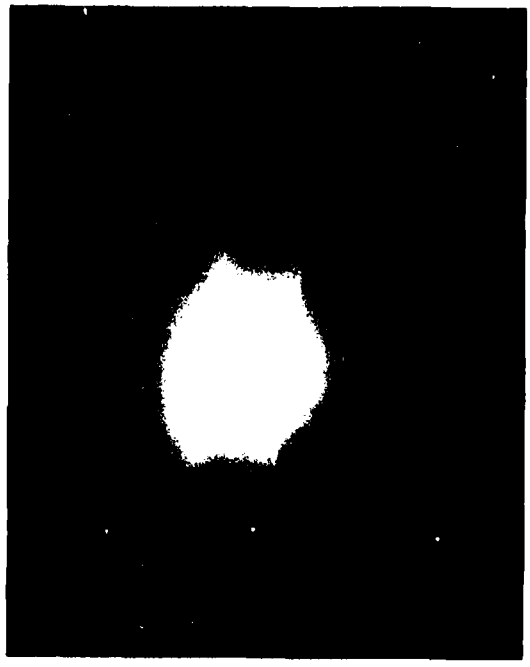


d) frame 4A E + 5 min 06 sec

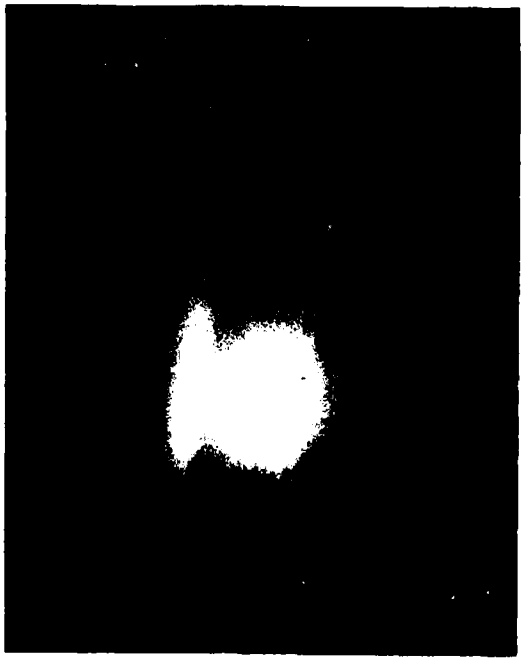
Figure 2.2 AVFERIA-UNO Event, Hot Creek Valley, NV, TIC Record 73909



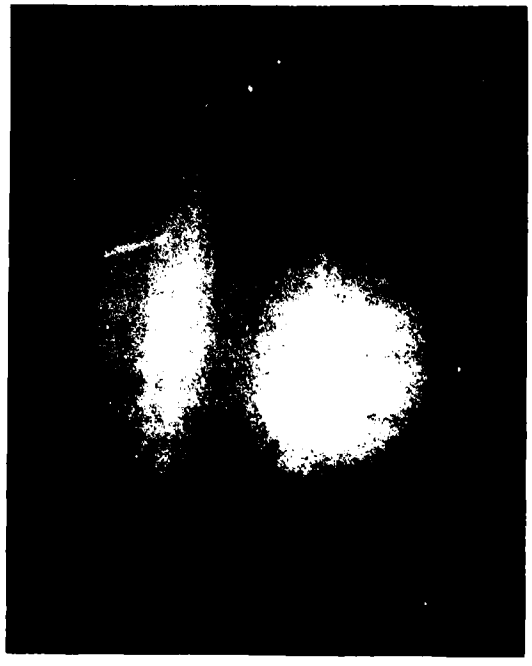
a) frame 3 T + 36 sec



b) frame 7 T + 1 min 39 sec



c) frame 11 T + 3 min 06 sec



d) frame 21 T + 6 min 10 sec

Figure 2.3 WEFRIA-1 NO Event, San Marcos Pass, CA. TIC Record 73941

2.2 AVEFRIA - DOS EVENT

The second Avefria event, Dos, behaved expectedly much like the Uno event. The early time jet formation and motion is shown in figure 2.4. In this group of four data frames covering as many seconds, a morphologically similar early ion cloud structure to that of the Uno event is seen. By E + 3 seconds, the (inner) ion structure cloud has moved out about 8 kilometers from the original detonation point. By E + 18 seconds (figure 2.5a) the ion cloud is seen to be relatively brighter than earlier; at this point in time the width of the observed structure is about 2 1/2 kilometers. In figure 2.5b the ion cloud is adopting its general characteristic form and the ion cloud structure is much more definitive. Also seen in this and the succeeding data frame are the track images of three sunlit rocket vehicle bodies as they descend from the detonation point on their normal trajectory. At E + 1 3/4 minutes, figure 2.5d; the Dos ion cloud, like the Uno ion cloud at a similar time, is striated at only one end of the cloud, and quite significantly so. The (projected) width of the left center group of about 16-18 striations is about 9 kilometers. (Note: Width defined perpendicular to striation axis).

The Dos cloud as seen from the Santa Barbara area from E + 1/2 minute to E + 7 minutes is shown in figure 2.6. The relative perspective geometry between Hot Creek Valley and Santa Barbara appears to be the same as suggested earlier for the Uno event. It is interesting to see (to the extent possible) the barely still visible expanding (debris) ring in the right hand 2/3 portion of figure 2.6a.

Beginning with figure 2.7 a series of sixteen high resolution photographs of the Avefria Dos event are presented for a 4 minute time span during which the Dos ion cloud passed through the magnetic zenith of the Hot Creek Valley optical site. The data frames selected are 2 second long exposures spaced in almost all instances 14 seconds apart. (The good contrast achieved in the

reproductions presented here was attained by making high contrast black and white internegatives from original color data frames under laboratory controlled conditions).

The value of this series lies in part in the fact that a given region of structure can be isolated for study while that region is within the magnetic zenith perspective. It is interesting to note that as the ion cloud drifts in a generally westerly direction, the magnetic zenith region (generally west southwest of Aquila ω^1 and ω^2) appears in more easterly (left direction) portions of the Dos ion cloud. In order to aid in the intrepretation of this series of photographic plates, a few representative dimensions of three selected frames throughout the series follows in the next few paragraphs.

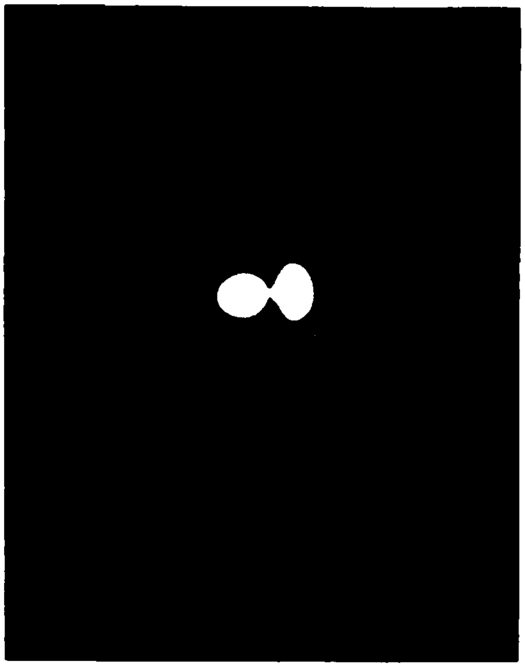
Data frame 58 (figure 2.8a) shows the ion and neutral clouds of the Dos event at E + 3 minutes and 35 seconds. If for discussion purposes one visualizes the likeness of an oriental "dragon" in the ion cloud image, the dimension between the eyes are 2.5 kilometers, the width of the most narrow (of many) tongue somewhat left of center is 150 meters, and the maximum vertical extent of the ion tail is 23.2 kilometers. The spherical neutral cloud at the lower center of the frame 58 image is 20.3 kilometers in diameter.

Data frame 76 (figure 2.10b) shows the ion cloud at E + 4 minutes 59 seconds with the overall cloud position shifted slightly west (to the right) of the magnetic zenith region identifiable in earlier frames. The last striation in the "tail" of the ion cloud is 220 meters in width and 8.5 kilometers in apparent length. The narrowest visible striation width in the lower right hand region of the "head" of the ion cloud is 150 meters.

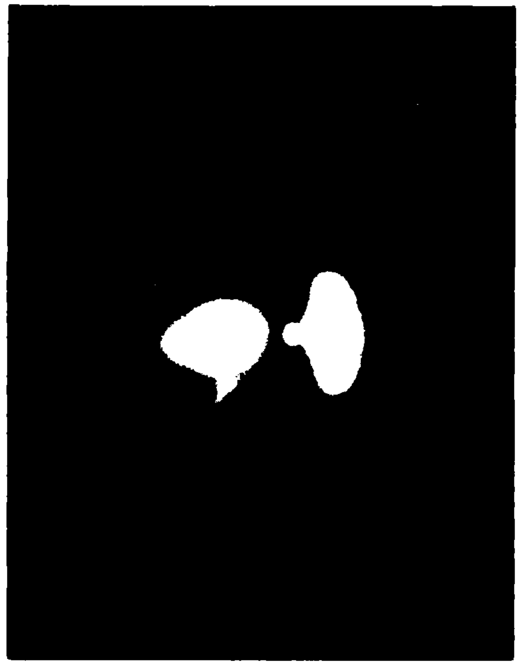
Data frame 103 (figure 2.14b) is the last data frame in this high resolution sequence and shows the Dos ion cloud at 7 minutes 7 seconds after release. Although the cloud has grown significantly in apparent size from the image shown in frame 58, the whole of the "neck" portion remained within the field

view of the 06 camera system. It is interesting to note that from the Hot Creek Valley site perspective the field aligned striations in the lower right ("head") portion of the ion cloud shown in frame 103 are closely aligned axially with certain of the striated structure in the upper left portion of the cloud. The "head" region of the ion cloud in the lower right contains striations as long as 10 kilometers maximum with a typical width of between 150 and 300 kilometers.

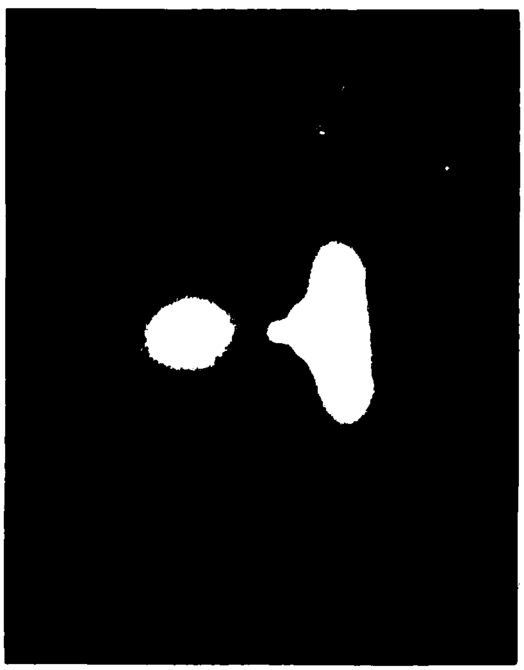
For reference, the Hot Creek Valley optics site viewed the Avefria events in the geographical direction of south south west at an approximate elevation angle of 65^{o}.



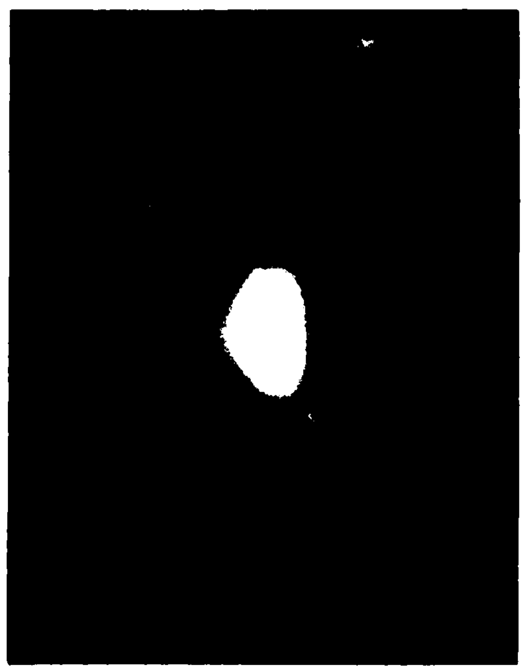
a) frame 1 (t = .25 sec)



b) frame 3 (t = .6 sec)

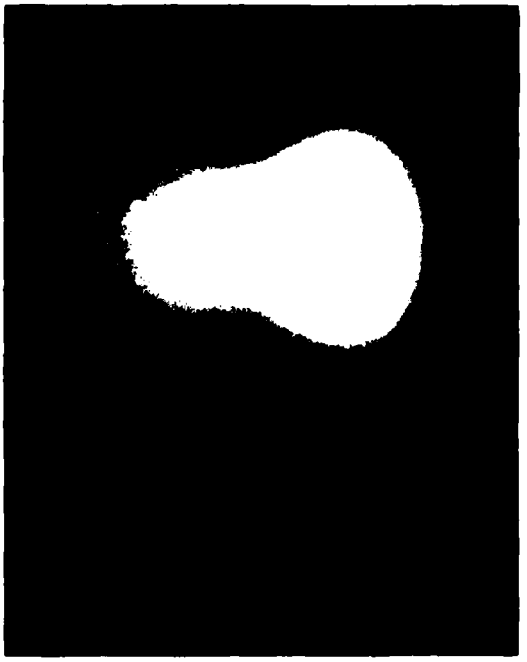


c) frame 6 (t = 1.1 sec)

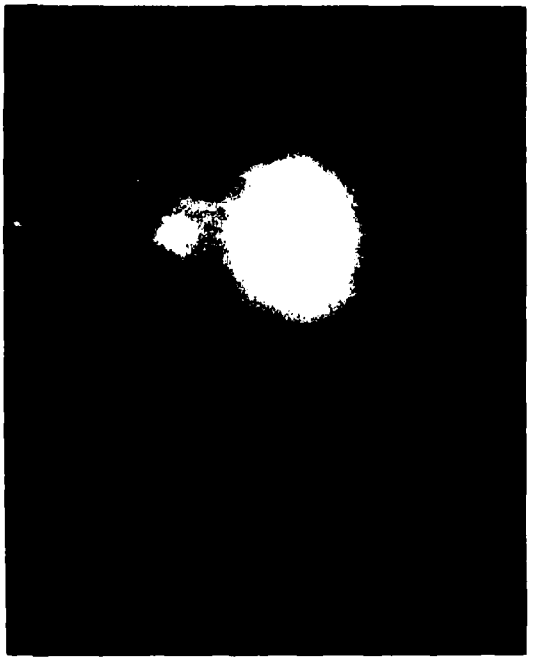


d) frame 21 (t = 3.6 sec)

Figure 2.4 [illegible] ERDA-DOE [illegible], Hot Creek [illegible], [illegible], [illegible] Record 74001



a) frame 9 E + 18 sec

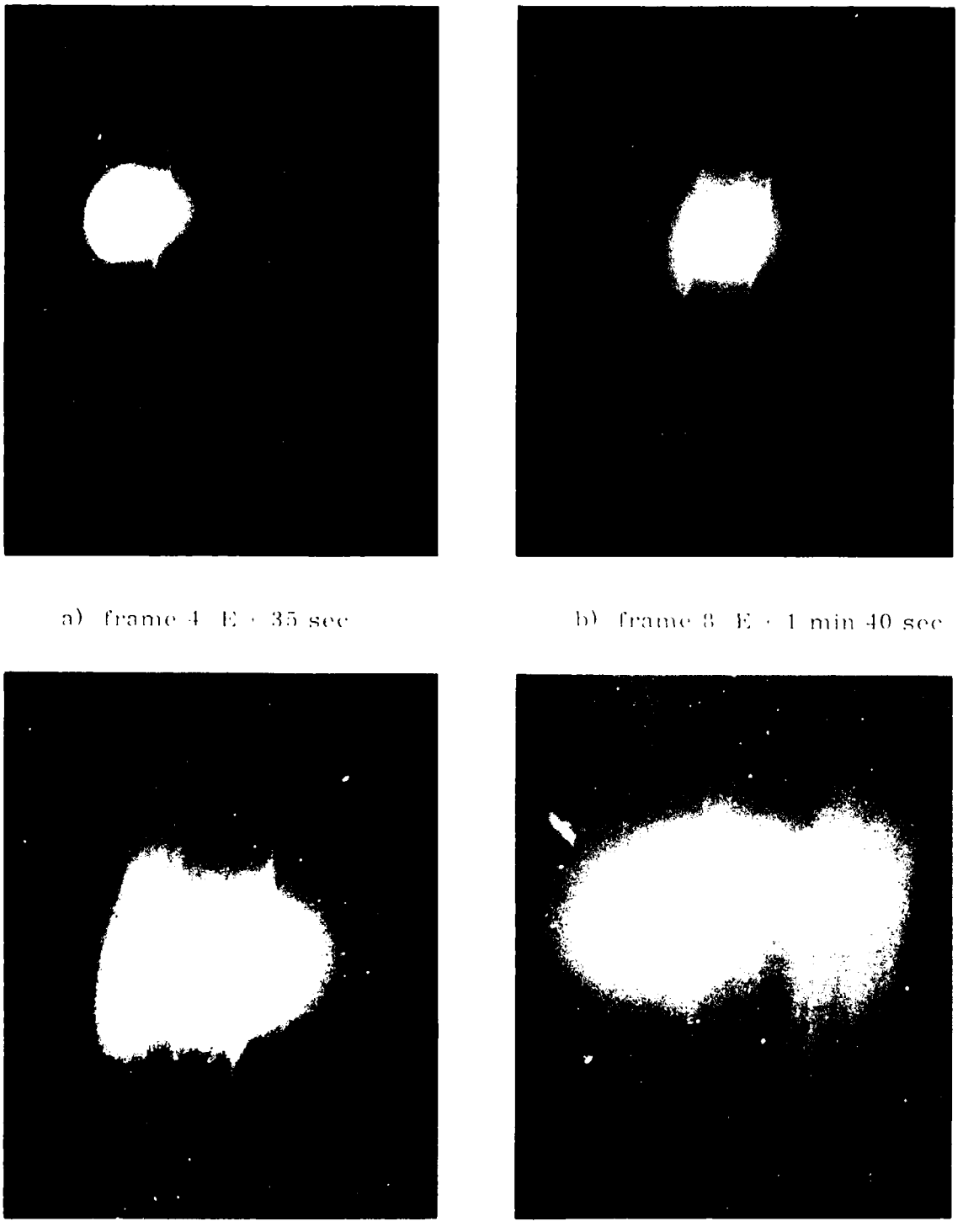


b) frame 17 E + 33 sec

c) frame 24 E + 54 sec

d) frame 34 E + 1 min 43 sec

Figure 2.3 AVLFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74007



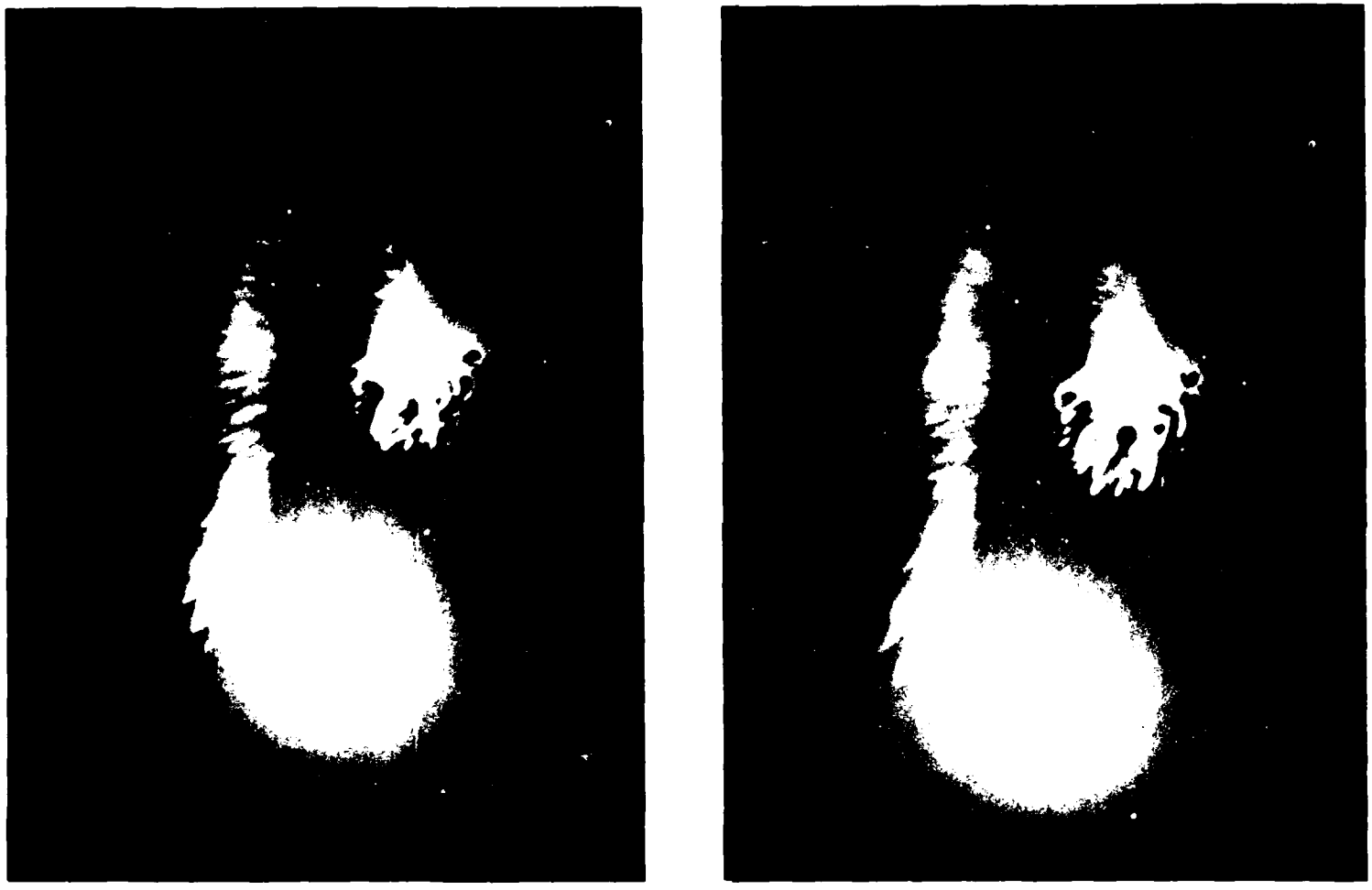
a) frame 4 E + 35 sec

b) frame 8 E + 1 min 40 sec

c) frame 14 E + 3 min 58 sec

d) frame 21 E + 7 min 01 sec

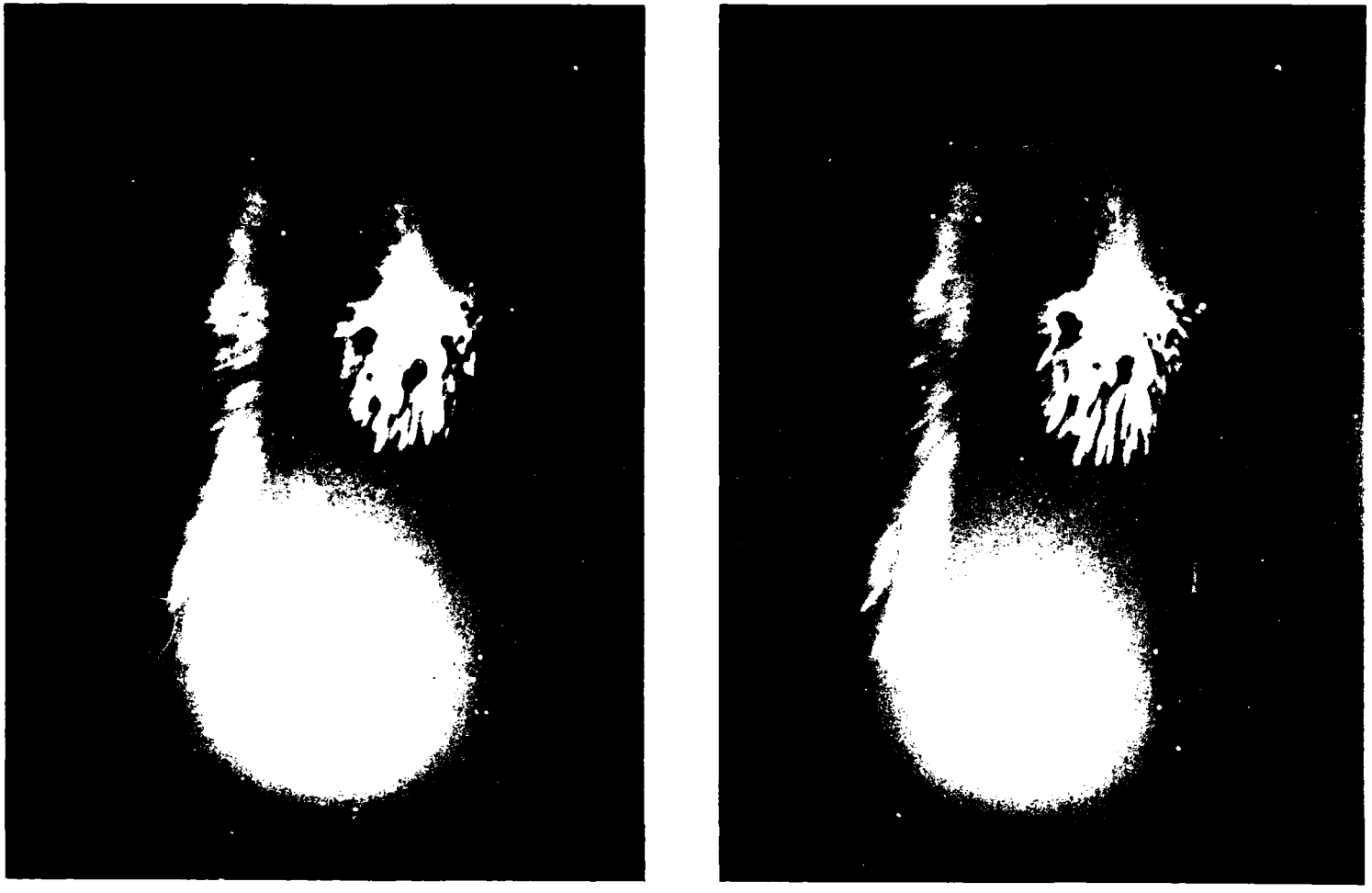
Figure 2.6 AVCERIA-DOS Event, San Marcos Pass, CA, TIC Record 74041



a) frame 52 E + 3 min 06 sec

b) frame 55 E + 3 min 21 sec

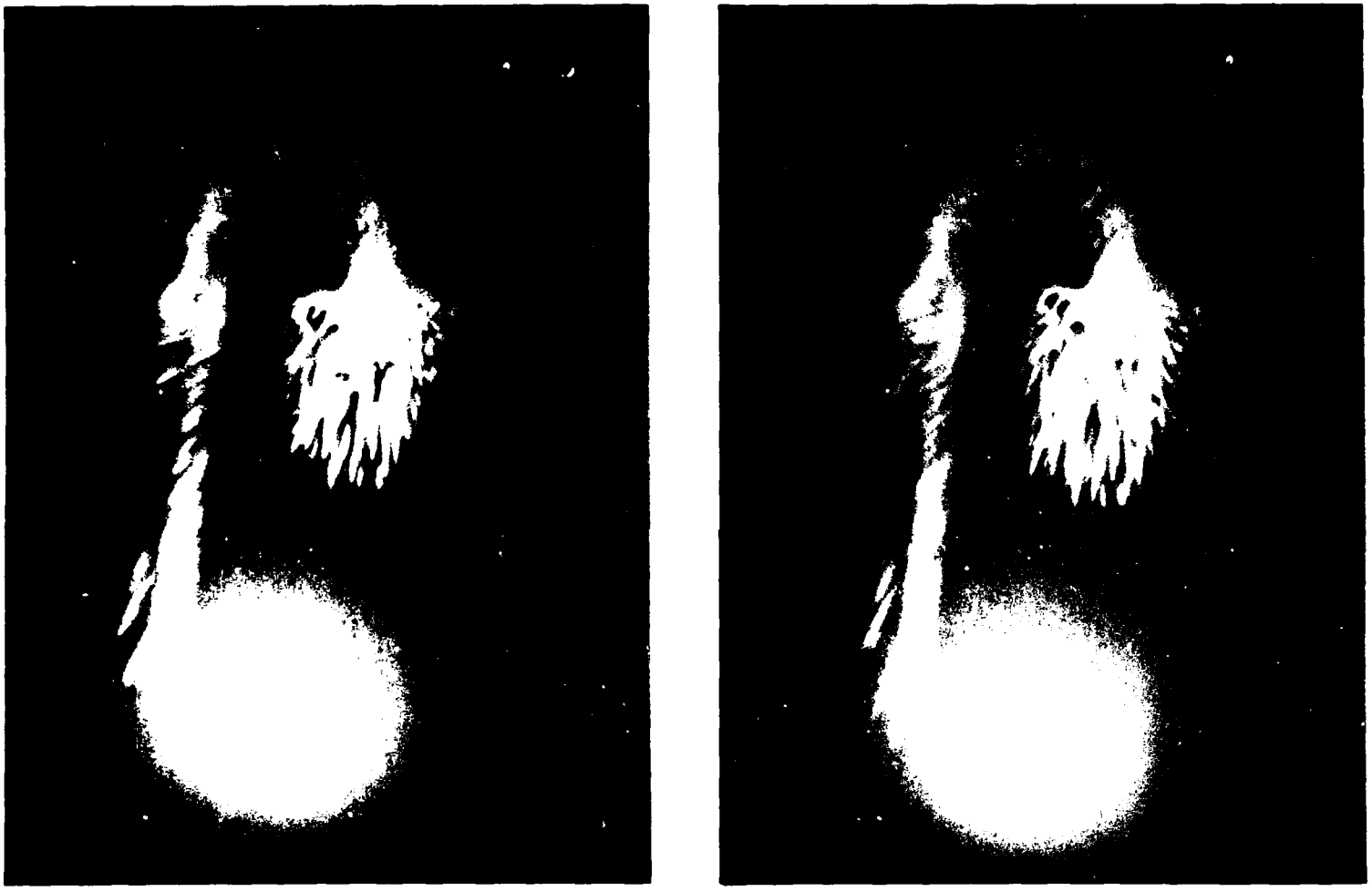
Figure 2.7 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006



a) frame 58 E + 3 min 35 sec

b) frame 61 E + 3 min 49 sec

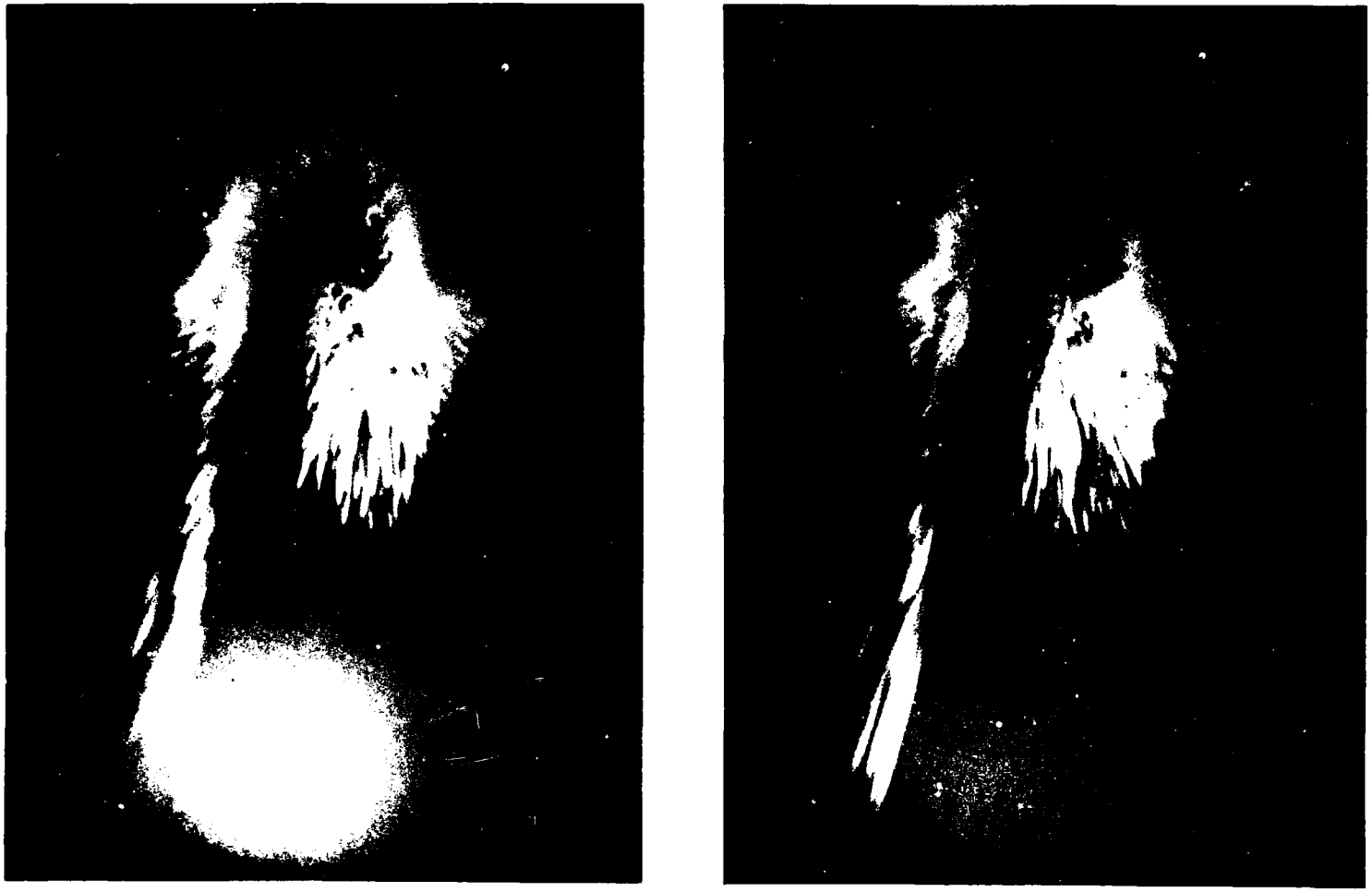
Figure 2.8 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006



a) frame 64 E + 4 min 03 sec

b) frame 67 E + 4 min 17 sec

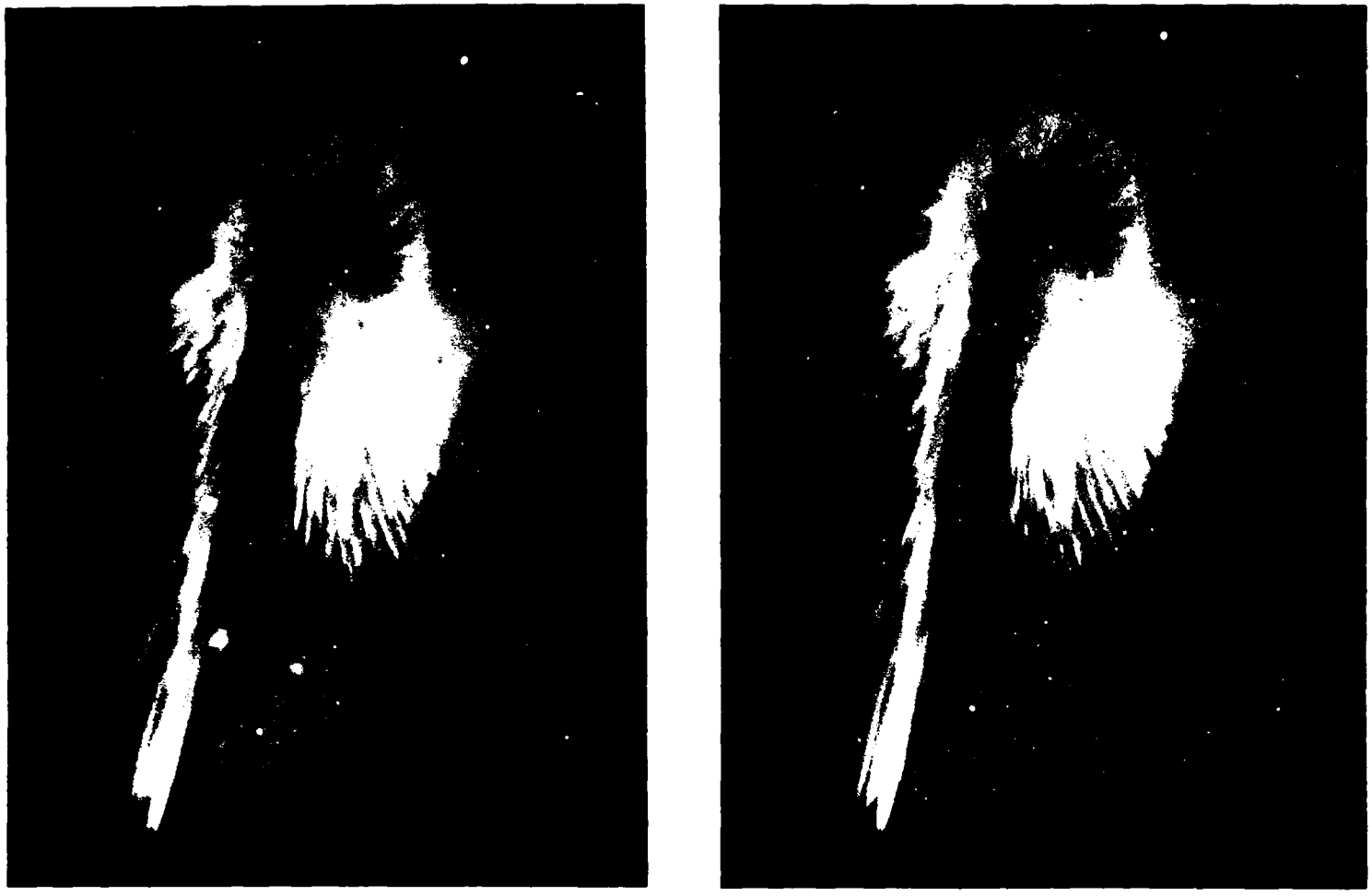
Figure 2.9 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006



a) frame 70 E + 4 min 31 sec

b) frame 76 E + 4 min 59 sec

Figure 2.10 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006



a) frame 79 E + 5 min 13 sec

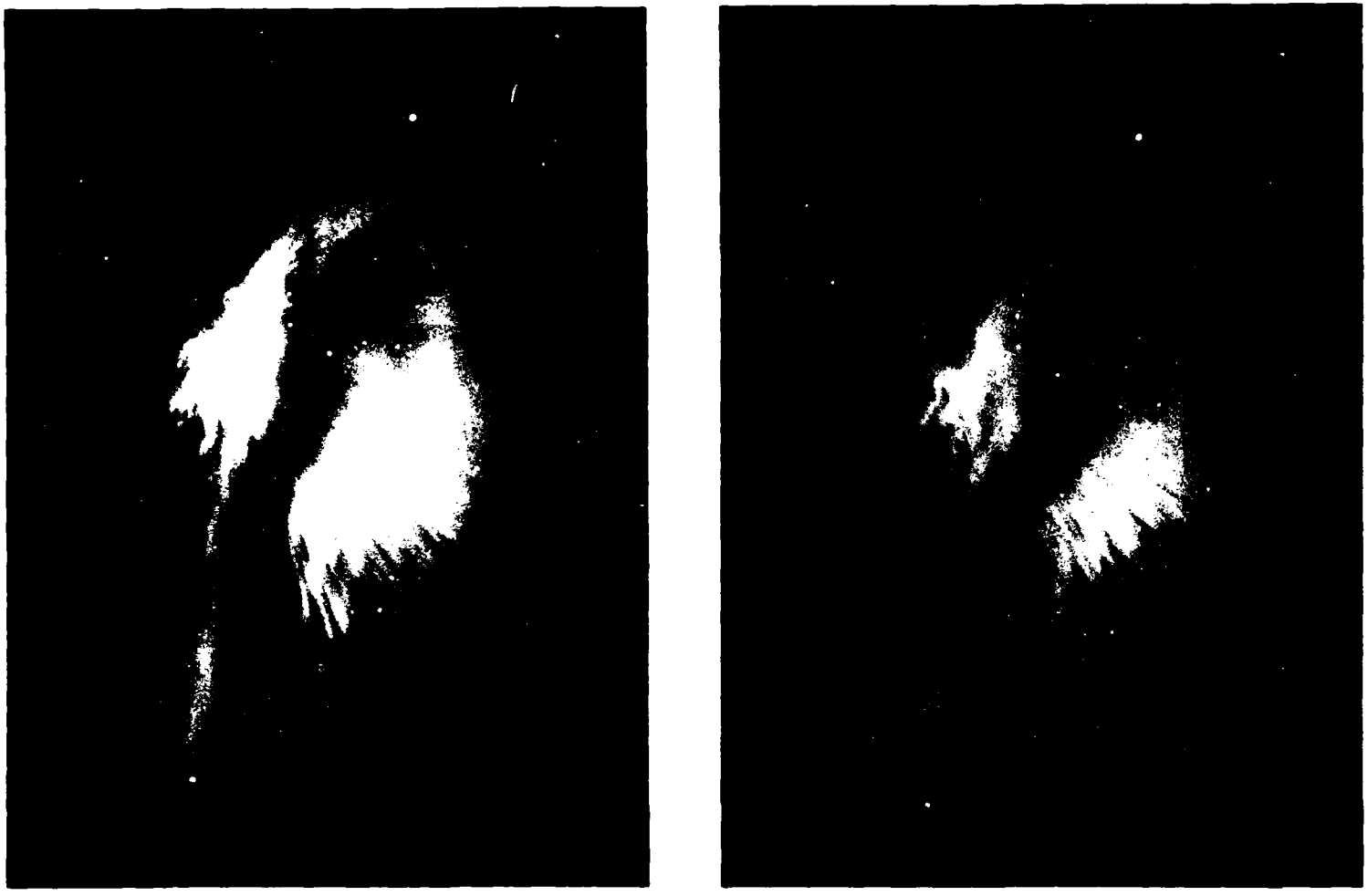
b) frame 82 E + 5 min 28 sec

Figure 2.11 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006

a) frame 85 E + 5 min 42 sec

b) frame 92 E + 6 min 14 sec

Figure 2.12 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006



a) frame 94 E + 6 min 24 sec

b) frame 97 E + 6 min 38 sec

Figure 2.13 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006

a) frame 100 E + 6 min 53 sec

b) frame 103 E + 7 min 07 sec

Figure 2.14 AVEFRIA-DOS Event, Hot Creek Valley, NV, TIC Record 74006

3.0 GEOMETRIC DATA REDUCTION

The Avefria shaped charge barium experiments were conducted at altitudes significantly less than previous such experiments and, thus, it was of interest to determine what motion velocities were manifested in the directed and diffusive expansion of the shaped charge release. In order to examine these cloud motions, slow framing cine cameras were operated by TIC at the Hot Creek Valley site in Nevada. As a compromise between temporal resolution and exposure irradiance minimums for a given type of photographic film, framing rates of between 6 and 10 frames per second were used for the two Avefria events.

3.1 SHAPED CHARGE EARLY MOTION MEASUREMENTS

The standardized barium shaped charge releases such as those used in the Avefria experiment display a uniformly characteristic release geometry and can, therefore, be compared for releases at different altitudes for purposes of correlation with atmospheric modeling and ion cloud (structure) formation in general. Using the detonation point as a reference, one first observes moving out along the direction of predominant motion a well defined expanding cloud consisting of a faster, narrower, central "jet" portion and a broader, slower moving, "shroud" portion enveloping the inner jet except at the outer tip region of the faster jet. (The jet shroud appears visually as a strongly hued yellow color with a greenish shell for several seconds).

Also occurring at the time of detonation is a rapidly (radially) expanding debris cloud from the shaped charge release configuration, defined within this report as the outer debris diameter or radius. Appearing essentially within the outer diffusive debris cloud at about E + 1/2 second is a shock enhanced region which typically assumes a cone shape within 1 to 2 seconds after release. This debris cone region remains the most readily identifiable geometry within the cloud as a whole for an additional several to 10 seconds by which time it has begun to diffuse into a spherical barium neutral cloud,

visually changing to the characteristic green neutral cloud color.

While the early jet and debris clouds are exhibiting the behavior as described above, an ion jet with developing structure is observed following the path of the early jet core. This structure appears initially after about 1/2 to 1 second after detonation, and is the nucleous of the developing ion cloud which remains structured throughout its visible lifetime for the Avefria events.

3.1.1 Avefria-Uno Event

Figure 3.1 shows the results of early motion measurements made on the Uno event data record 73901. The fastest measured velocity is that of the narrow directed jet whose projected motion to the Hot Creek Valley observer is approximately 12 kilometers per second. At about 0.6 second the jet separates from a more slowly moving shroud whose velocity is about 5 1/2 kilometers per second in the axial direction.

The inner ion cloud jet whose early structure is becoming evident by 1 second (figure 2.1b), is seen to have extended to 6 kilometers from the detonation point by this time. The extent of the major structured region at this time, however, is the order of 2 kilometers across its width.

Also shown in figure 3.1 is the radius (not diameter) of the outer debris cloud and the inner cone shaped early shocked region of the cloud. The outer debris cloud, which forms the subsequent barium neutral cloud (including the cone shaped portion), is seen to be about 13 kilometers in diameter for the Uno event at E + 2 seconds.

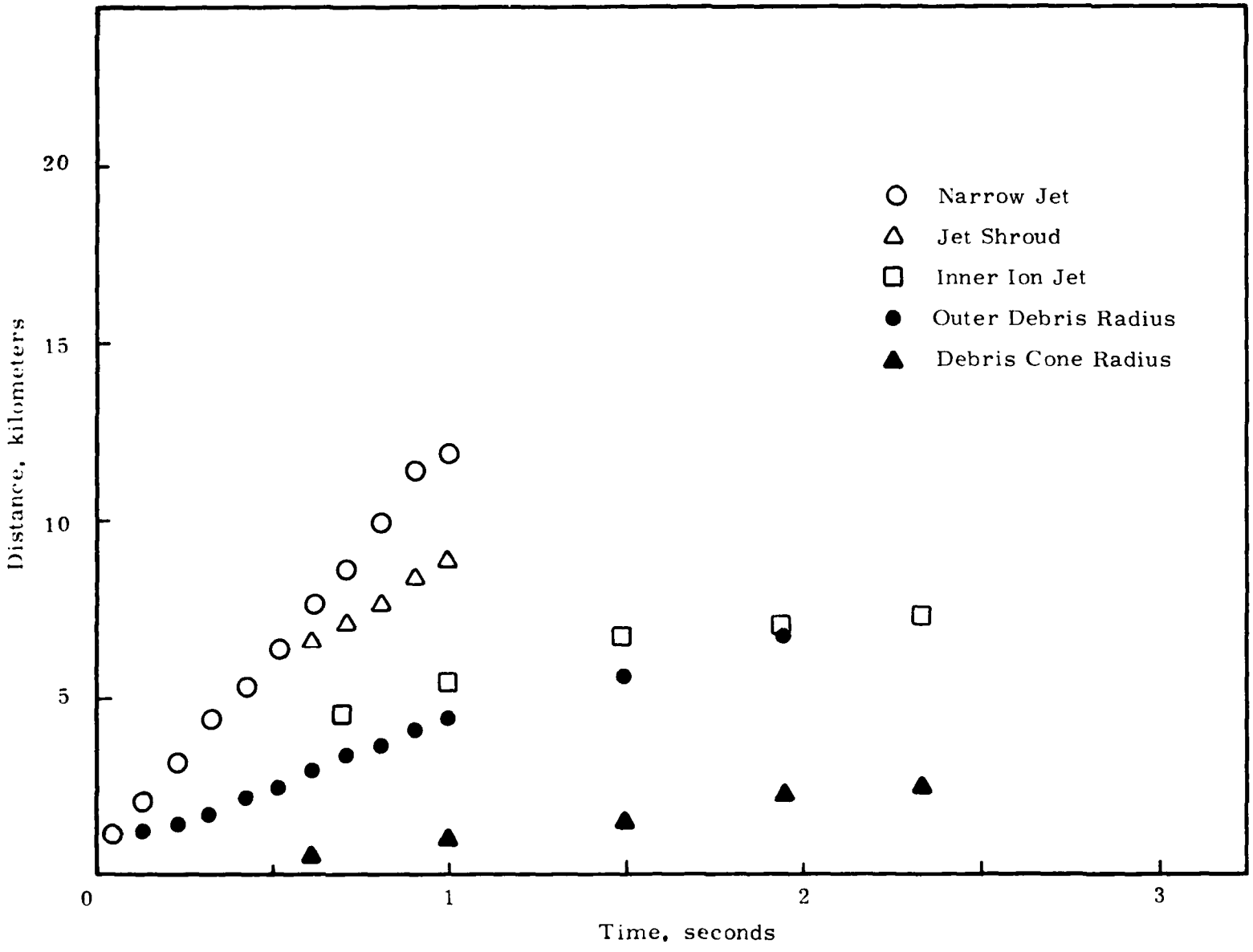


Figure 3.1 AVEFRIA-UNO Event, Early Motion Displacement, TIC Record 73901

3.1.2 Avefria-Dos Event

The early motion measurements made on the Dos event, derived from data record 74001, are presented in figure 3.2. The overall geometrical development characterized by this early motion data is clearly similar to that shown for the Uno event in figure 3.1 with the exception that the measured parametric displacements velocities are somewhat greater for the Dos event. Based upon the same assumed slant range of 217.5 kilometers used for the Uno event calculations, the Dos event narrow directed jet motion is found to be about 14 kilometers per second averaged over the first second.

The previously defined inner ion jet portion of the developing cloud was not observed until about E + 1 second for the Dos event. It is seen, however, to extend about the same distance from the detonation point - - about 8 kilometers - - as the ion jet in the Uno event.

In making comparisons between the early motion measurements of the Uno and Dos events it would seem that there is little significant difference insofar as developing a model is concerned. What differences do exist might be attributable to the potential variation in payload performance, minor differences in detonation height, or possibly differences in injection angle relative to the observer.

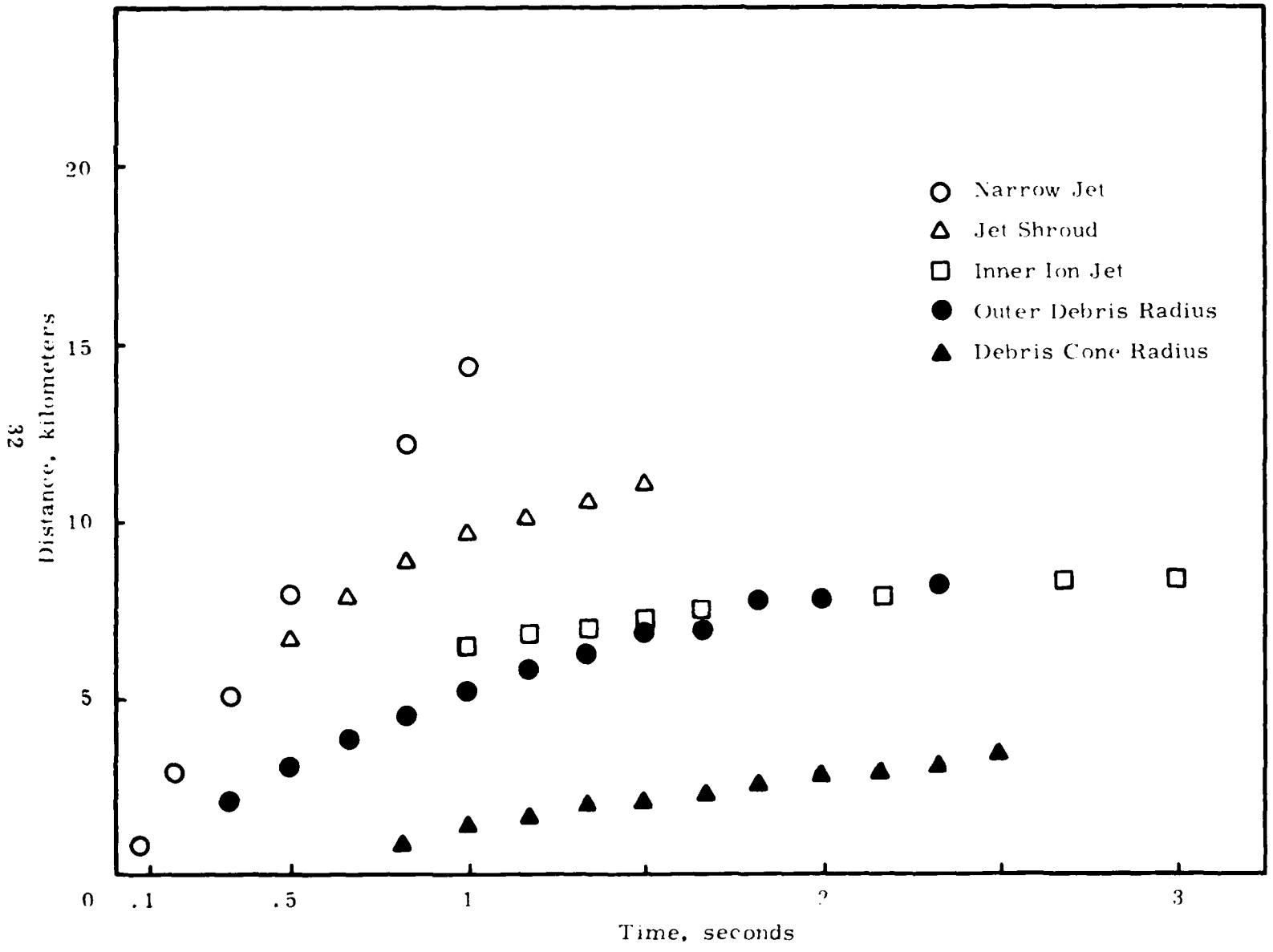


Figure 3.2 AVEFRIA-DOS Event, Early Motion Displacement, TIC Record 74001

4.0 RADIOMETRIC DATA REDUCTION

The data reduction program undertaken by TIC included a specific effort to determine the peak radiance time history of the Avefria-Dos event ion cloud cloud for correlation with a similar data reduction effort by LASL and EG&G, Inc. The radiometric measurements are derived from data record 74005 which was obtained with a narrow band interference filter camera using Kodak Tri-X film and a 4554Å barium ion filter. The data record taken by TIC was processed by EG&G, Inc. and an absolute D log E film characteristic curve calibration was also provided to TIC.

Eight data frames from the 74005 record were selected for radiometric analysis. The time regime of this data covered E + 6 seconds to E + 9 1/2 minutes. A two-dimensional density contour was made for each of the eight data frames and the peak density region determined for the ion cloud image in a particular frame. The density value was converted to an effective exposure value and then to source radiance using transmission values of 0.5 for atmospheric transmission, 0.5 for the 4554Å interference filter transmission, and 0.7 for objective lens transmission.

The results of the peak radiance calculations using the EG&G, Inc. absolute calibration (based upon a 4 second exposure time) are plotted in figure 4.1. A generally consistent curve is obtained with the exception of the small rise in peak radiance between 2 and 3 1/2 minutes. This slight variation is possibly due to the enhanced atmospheric sky background in the photographic image due to the longer effective exposure of the images beyond E + 2 minutes, (i.e. from 2 second exposures to 4 second exposures).

An independent check of the D log E curve calibration technique was made using Kodak supplied batch data film sensivity values. Using these Kodak values, peak radiance values differing by only about 20 per cent (lower) from those derived using the EG&G, Inc. calibration data were obtained.

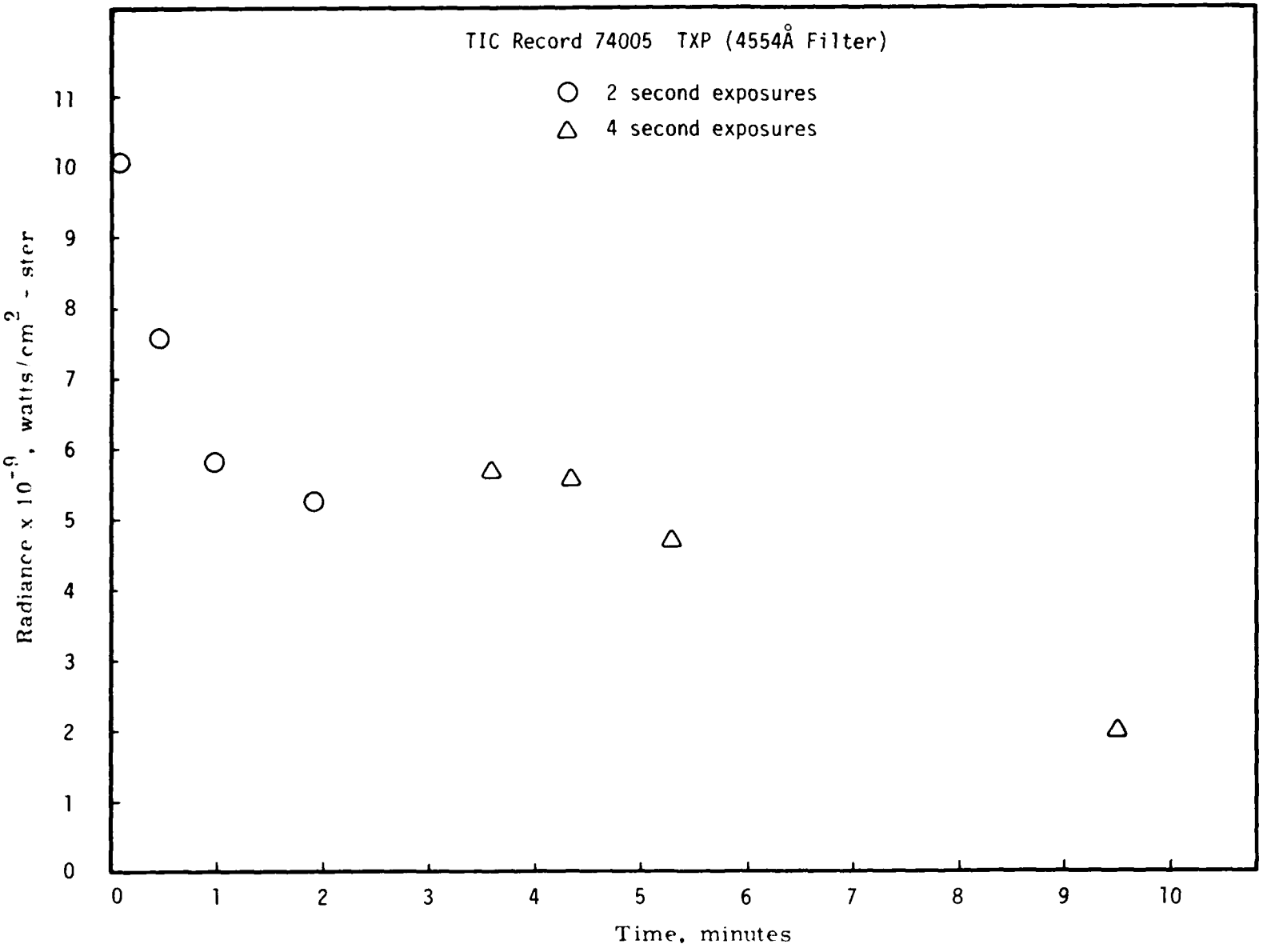


Figure 4.1 AVEFRIA-DOS Event, Peak Radiance Time History, TIC Record 74005

APPENDIX A

INSTRUMENT PLANS

APPENDIX A

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: AVEFRIA **DATE:** 8 MAY 1978 **STATION:** PRIMARY

EVENT: I **LOCATION:** H.C.V. NEVADA **PROJ./ENGINEER:** DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
01	GCC	135mm	-	2484 35mm x 150'	1.5	10 fps 170°	8 x 11°
02	GCS	135mm	-	TXP 35mm x 100'	1.5	3 fps 170°	8 x 11°
03	FR IV-C	50mm	-	EP-200 35mm x 100'	0.95	2 sec	21 x 28°
04	B-C'D	135mm	-	EP-200 70mm x 100'	1.5	P-1	24 x 32° clock
05	B-C'E	105mm	4554	2484 70mm x 150'	0.75	P-1	21°
06	300 DELFT	300mm	-	EP-200 70mm x 15'	0.90	P-2	10°
07	300 EK	300mm	-	2484 70mm x 100'	2.5	P-2	11 x 14° clock
08	TSI	135mm	4554	TXP 70mm x 15'	1.5 .95/2.8	manual	12°
09	T-10	254mm	-	TXPP RXP 4 x 5	1.3	manual	20°

ADDITIONAL INFORMATION:

APPENDIX A

TECHNOLOGY INTERNATIONAL CORPORATION

INSTRUMENT PLAN

OPERATION: AVEFRIA **DATE:** 18 MAY 1978 **STATION:** PRIMARY

EVENT: II **LOCATION:** H. C. V. NEVADA **PROJ./ENGINEER:** DNA/RAAE

POSITION	INSTRUMENT	FOCAL LENGTH	FILTER	FILM	f/n	SHUTTER/RATE	REMARKS
01	GCC	135mm	-	TXP 35mm x 150'	1.5	6 fps	6 x 11°
02	GCS	135mm	-	EP-200 35mm x 100'	1.5	4, 2 fps 170°	8 x 11°
03	FR IV-C	50mm	-	EP-200 35mm x 100	0.95	2 sec	21 x 28°
04	B-C/D	135mm	-	EP-200 70mm x 100'	1.5	P-1	24 x 32° clock
05	B-C/E	105mm	4554	TXP 70mm x 100'	0.75	P-1	21°
06	300 DELFT	300mm	-	EP-200 70mm x 15'	0.90	P-1	10°
07	300 EK	300mm	-	2484 70mm x 100'	2.5	P-1	11 x 14° clock
08	TSI	135mm	4554	TXP 70mm x 15'	1.5 .95 2.8	manual	12°
09	T-10	245mm	-	TXPP RXP 4 x 5	1.3	manual	20°

ADDITIONAL INFORMATION:

APPENDIX B

DATA RECORD SUMMARIES

APPENDIX B

TECHNOLOGY INTERNATIONAL CORPORATION

DATA RECORD SUMMARY

OPERATION: AVEFRIA DATE: 8 MAY 1978 STATION:

EVENT: UNO LOCATION: PROJ. ENGINEER:

RECORD NO.	FILM TYPE		RECORD SUMMARY
73901	2484	10 fps	Well exposed cine record of release, covers E = 0 to E + 20 - 30 seconds.
73902	TXP	3 fps	Very good image definition of release, early ion cloud to E + 15 seconds.
73903	EP-200 Color	2 sec	Excellent time lapse record in color showing striation formation to E - 7 minutes.
73904	EP-200 Color	2, 4, 8 sec	Very good color morphology record, shows ion and neutral clouds to E + 11 minutes.
73905	2484	2, 4, 8 sec	Good ion filter record (4554A°), covers ion cloud to E +12 minutes plus.
73906	TXP	2, 4 sec	Camera mag. malfunctioned - no useable record.
73907	2484	2, 4, sec	Fair record only, sky background heavy, tracking only moderately good. Note: First two frames show ballistic track of payload before and after detonation.
73908	TXP	manual	Good random images of ion cloud through three stage intensifier.
73909	TXPP	manual	Good wide field coverage, exposures too long (5 seconds) for good definition of structure.

APPENDIX B

TECHNOLOGY INTERNATIONAL CORPORATION

DATA RECORD SUMMARY

OPERATION: AVEFRIA DATE: 18 MAY 1978 STATION: _____

EVENT: DOS LOCATION: _____ PROJ. ENGINEER: _____

RECORD NO.	FILM TYPE		RECORD SUMMARY
74001	TXP	6 fps	Very good cine record of detonation to E + 15 seconds.
74002	EP-200 Color	4 fps	Excellent color cine record showing 3 stages of shock boundaries in first 2 seconds. 24 frames at 4 fps; 17 frames at 2 fps.
74003	EP-200 Color	2 sec	Excellent time lapse record in color. Shows striation development through magnetic zenith perspective. Neutral cloud out of field ov view after E + 4 minutes.
74004	EP-200 Color	2, 4, 8 sec	Very good color morphology record. Shows ion and neutral cloud development to E + 12 minutes.
74005	TXP	2, 4, 8 sec	Very good filter camera record of ion cloud structure to E + 21 minutes.
74006	EP-200 Color	2, 4, 8 sec	Excellent high resolution data of ion cloud striations from E + 3 minutes to E + 7 minutes.
74007	2484	2, 4, 8 sec	Very good b/w equivalent of 74006 except covers E = 0 to E + 11 minutes. Shows expanding debris ring with good resolution at E + 20 seconds.
74008	TXP	manual	Very good random intensifier images, some with ion filter.
74009	TXPP	manual	Good large field record of ion and neutral cloud. 14 data frames.

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